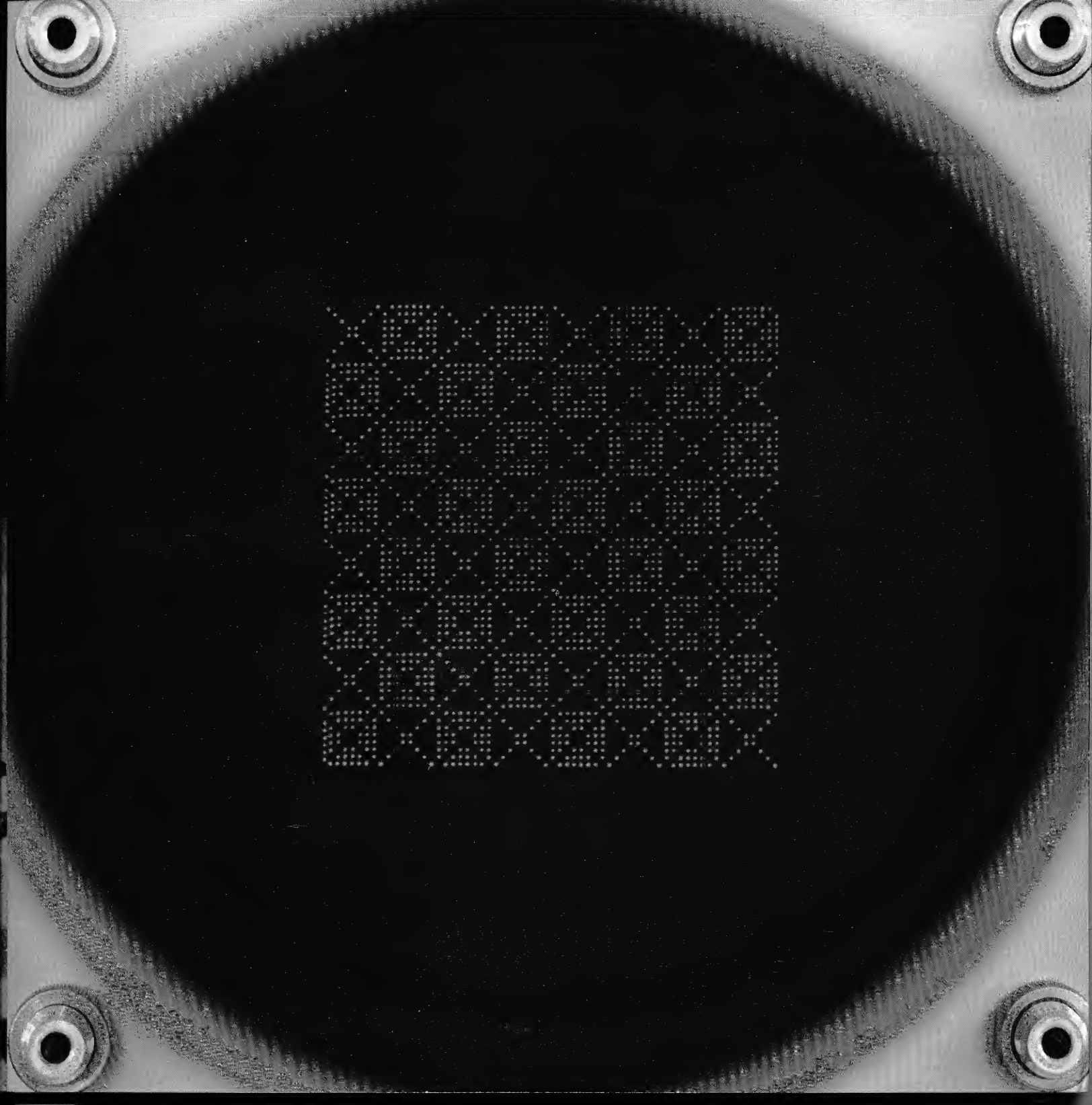
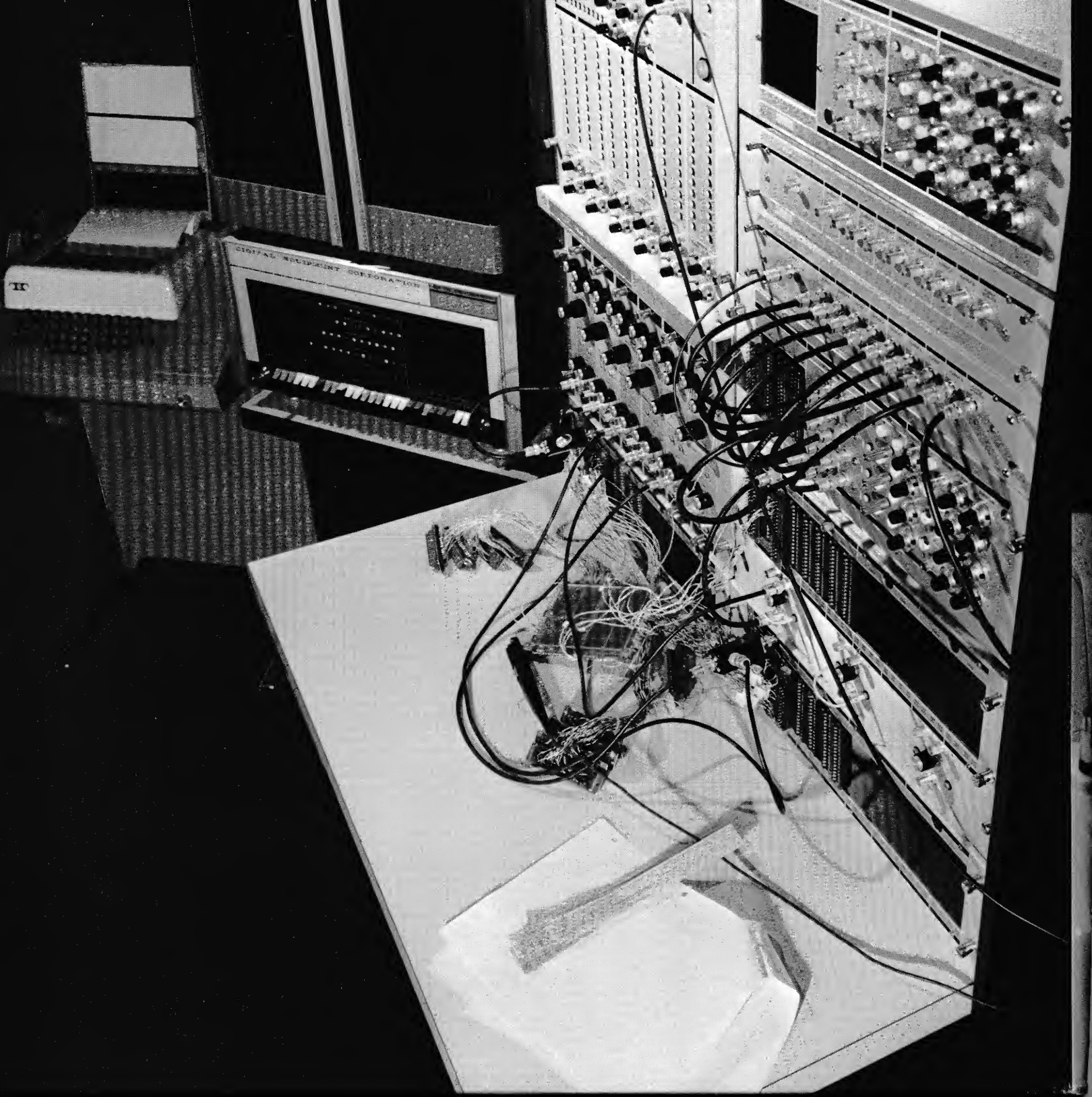




digital PMA-8

A COMPUTER-CONTROLLED MEMORY ANALYZER





SPECIFICATIONS AND MAINTENANCE

The PMA-8 is constructed so that it is easy to remove or install subsystems. The computer-controlled analyzer's design also permits the operator to get into the system quickly to calibrate components or perform routine preventative maintenance.

The modular PMA-8 is housed in two cabinets. One cabinet contains the complete PDP-8, which serves as the central control for the memory testing system. The second cabinet contains the modular current drivers, switching systems, sense amplifiers and discriminator subsystems, which are all self-contained units that are easy to remove for checkout or maintenance. The PMA-8's teleprinter is a separate unit.

The PMA-8 system can be expanded quickly and easily with optional plug-in modular subsystems.

Maintenance

The computer in the PMA-8 has a complete set of routines to checkout the system. Although an operator can perform routine checkouts, DIGITAL has field service representatives available world-wide in the rare event that trouble should occur.

An added maintenance feature of the PMA-8 is that an operator can manually checkout the test frame while the computer is being used for other things. The logic components in the test frame are almost exclusively flip-flop

Optional input-output devices, such as plotters, are available for the PDP-8. They can be connected to a bussed interface without modifying the computer. The PDP-8's standard input-output device is a Teletype ASR-33, including paper-tape punch and reader.

Software includes a FORTRAN compiler, a symbolic assembler, symbolic on-line debugging, and a symbolic tape editor. Standard testing programs are available for all memories presently in use. A standard logic addressing capability of $256 \times 256 \times 64$ is supplied and can be expanded.

Test Frame

The PMA-8's memory test mainframe includes:

- Six current drivers

- One 2700 difference amplifier

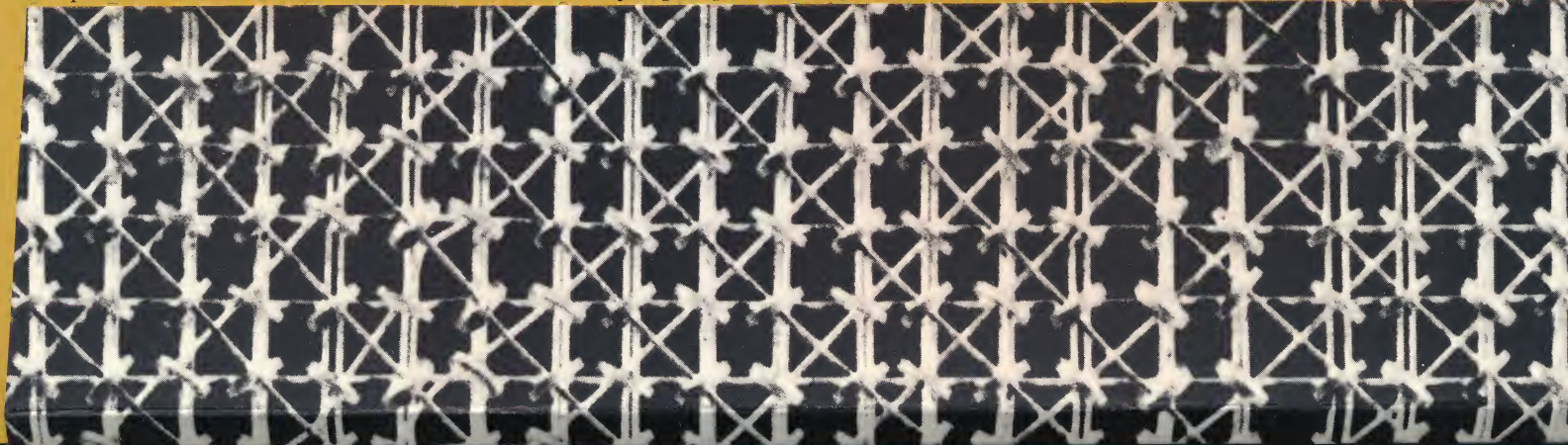
- One 2701 variable gain amplifier

- Two 2712 discriminators (one 4-channel, one 2-channel)

- Six variable-width strobes with an associated programmable reference level. The 2712 discriminators are used to analyze the output of the dual 2700/2701 linear sense amplifiers.

Switching System

Type and size is specified by the customer. Both reed-relay and solid state configurations are available.



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An added maintenance feature of the PMA-8 is that an operator can manually checkout the test frame while the computer is being used for other things. The logic components in the test frame are almost exclusively flip-flop registers which the computer loads and unloads. But, ninety percent of the logic can be identified and checked out without using the computer.

If a module becomes defective, the operator simply pulls it out and plugs another one in, so that the PMA-8 will be back in operation quickly.

Programmed Data Processor (PDP)-8 Computer

The PDP-8 has a 4096 (12-bit) word core memory that can be expanded. Its memory cycle time is 1.5 μ sec, addition 3 μ sec. It has indirect addressing, program interrupt, and high-speed data break. The input-output transfer rate is 2 to 7.8 million bits per second.

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Options

Specially engineered environmental chamber switching system including integral current drivers, address switches, and termination networks. Can be mounted on wall or door of environmental test chambers.

Oscilloscope Display

Incremental Plotter

Current-Voltage Calibrator

Additional switching systems and current drivers.

Power Requirements

105-115 single-phase, AC power, 60N, 30 amps. 105-125 VAC or 220-235 VAC, 50N, optional.

MAIN OFFICE AND PLANT

146 Main Street, Maynard, Massachusetts 01754
Telephone: From Metropolitan Boston: 646-8600
Elsewhere: (617)-897-8821
TWX: 710-347-0212 Cable: Digital Mayn. Telex: 94-8457

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Telephone: 32 25 98



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ATTN: DIGITAL TEST DEPT.

INFORMATION REQUEST

Please send technical literature on the new, high speed PMA-8

I would also like information on:

- ☐ Memory Core Testers ☐ Memory Exercisers ☐ Programmable Pulse Generators
☐ Current Drivers ☐ Current Calibrators ☐ Digital Modules

Other: _____

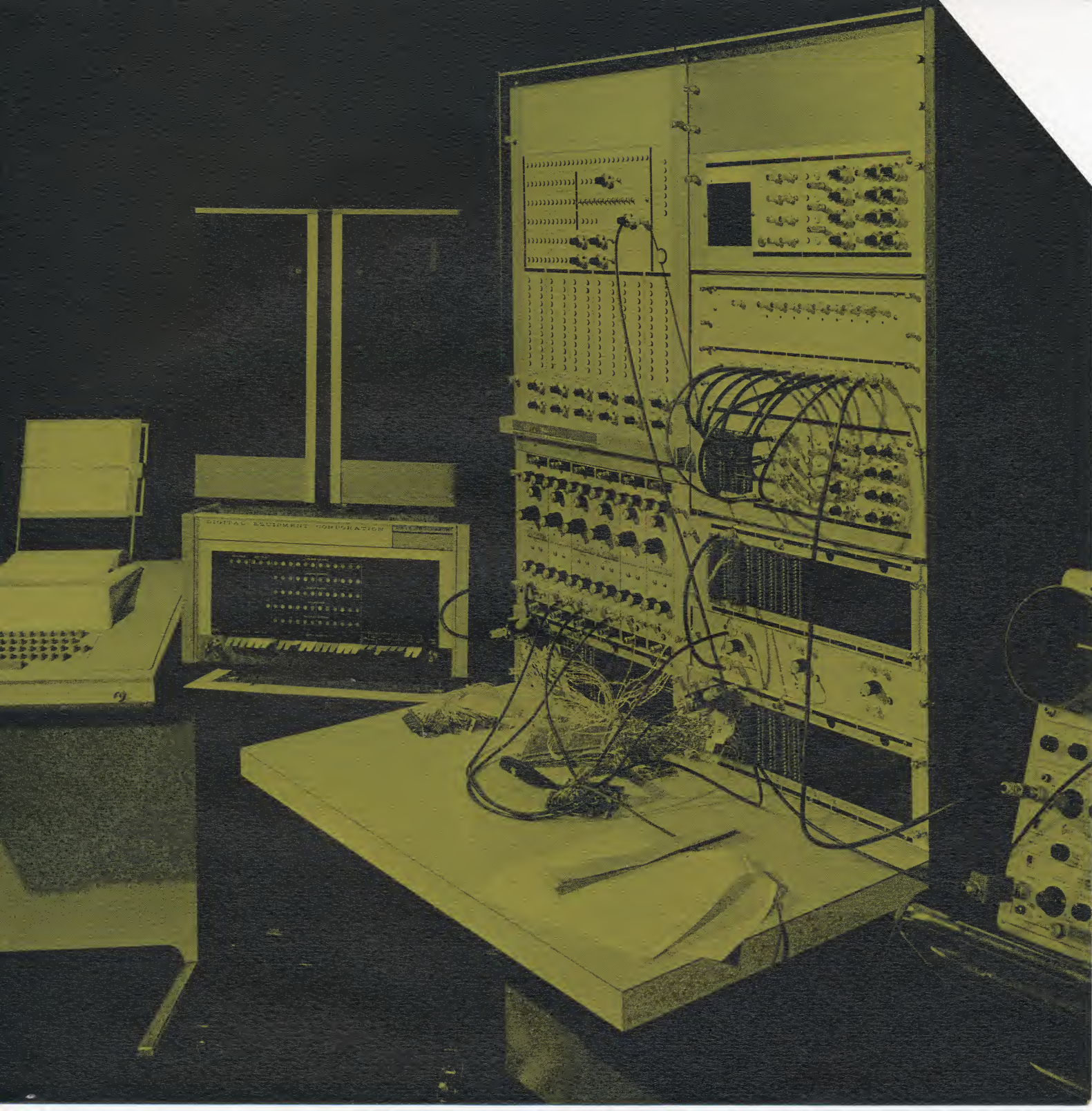
- ☐ Add my name on your mailing list to receive Magnetic Testing Application Notes.
☐ Please have a Digital engineer call me for an appointment.

Name _____ Title _____

Company _____ Business _____

Street _____ Telephone _____

City _____ State _____ Zip Code _____



A COMPUTER-CONTROLLED MEMORY ANALYZER DESIGNED FOR CHANGE

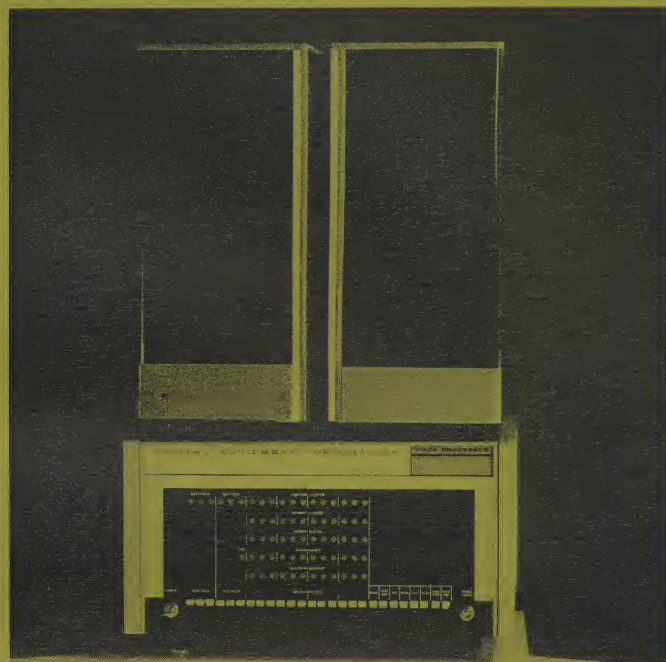
Change is part and parcel of memory testing — the types of memories change, requirements change, test procedures change.

DIGITAL'S Programmed Memory Analyzer, the PMA-8, is designed to live with change. It has the built-in flexibility of a general-purpose computer, DIGITAL'S PDP-8, combined with a test frame that can be modularly expanded.

Whether you are in an engineering laboratory or on an assembly line, testing a simple coincident-current unit or plotting a multi-sense, multi-inhibit memory — 2D, 2½D, 3D, plated-wire, or experimental, the PMA-8 is programmed and can be calibrated faster than you can plug-connect the memory to the test frame.

And, you get increased test definition. You can easily generate multi-layered checkerboard test patterns, for example. Or, disturb bursts as long as 99.9 milliseconds with no limitations in step sequencing.

The PMA-8 reduces the amount of time you spend "knob turning." It has built-in test and pattern instructions — you don't have to write your own computer programs.



The PDP-8

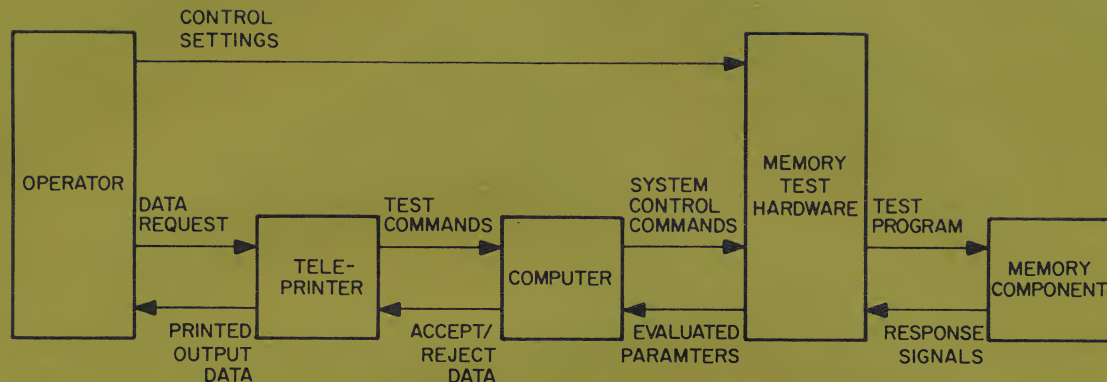
It's also an easy system with which to interact, since you can communicate with it in English — there are no complicated computer languages to learn.

Being able to interact with the PMA-8 means that you can observe output data or change test parameters during testing. This reduces the amount of retest necessary.

You can calibrate the current drivers and strobes while memory input data is reading in or out. And, you can output your data to the console Teletypewriter or a plotter. All input operations are separated from output operations. The PMA-8 can control more than 190 input/output devices.

When you are not using the PMA-8 for testing, you can use the PDP-8 as a general-purpose computer. The high-speed PDP-8 has a basic memory of 4,096 (12-bit) words that can be expanded to 32,768 words.

Training is another part of a PMA-8 package. DIGITAL conducts courses in computer technology, programming, and logic design especially for its customers.



The Heart of the System

The central control element in the PMA-8 is DIGITAL's time-proven PDP-8 computer. The computer is also the primary communications link between the operator and the memory analyzer.

The operator inputs test information to the computer using either paper tape or directly typing the data on the PMA-8's Teletypewriter/teleprinter. Testing parameters are stored in the computer in the form of reference tables, and the PMA-8 uses data extracted from these tables to analyze the memory test data.

The "working parameters" table is used to store data for test routines. The "pseudo-instruction" table is used to store groups of parameters that can be identified by the operator through any simple name, such as SHMOO or GO/NO GO.

When the operator wants to use a specific test or plot, he types the name of the test or plot on the Teletypewriter. The computer, using the pseudo instruction table, assembles the selected group of testing parameters. The operator is not limited to these parameters, however. If he chooses he can go directly to the "working parameter" table and use parameter values from it. Or, he can even introduce new values.

Usually, the operator uses a short paper tape provided for the memory under test. These standard memory data tapes come with the PMA-8. You can also prepare your own tapes, if you choose.

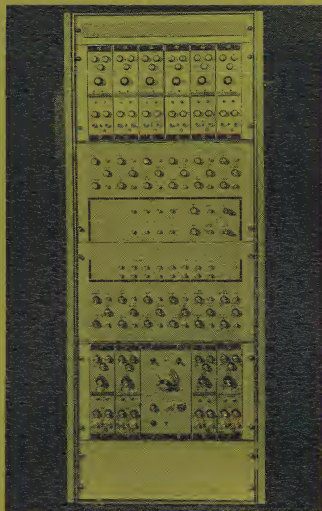
The memory tape sets the parameters in the "pseudo-instruction" table to define the size of the memory, the worse case pattern, the pulse program, the number of strobes, the time states in which the strobes are to be used, etc. These are fixed parameters defined by the tape and are not modified directly by the operator. Once the tape is loaded, there are very few parameters with which the operator must work.

Calibration

The PMA-8's switching system receives current driver pulses and directs these pulses to each coordinate in the test memory. Before testing, the operator adjusts the current drivers to optimize current pulses, positions the strobes, and measures strobe width. Each current driver and strobe has its own 12-bit hardware register that enables and disables it under computer control.

With the PMA-8's built-in pulse program, the operator can select up to 16 sense output lines per plane in any arbitrary winding configuration for output signal evaluation.

PMA-8 Optional Environmental Chamber Switching System



The pulse program can be up to 12 steps long, thus making the PMA-8 equivalent to a 24-bit, hard-wired machine, since each bit can be associated with either a "one" or "zero" under computer control. Conventional systems require longer program lengths because the program is split in half — one half for "ones" patterns, and the other half for "zeros." The steps in the pulse program can be paired, step-repeated, and sequenced.

The pulse configuration for a time state (read enable, write enable, or disturb pulse bursts) is determined prior to testing. If the bit of the register associated with time-state 1 contains a "one," that current driver will be turned on during that time state, and again during any time state associated with the bit; i.e., time state 1, bit 1, time state 8, bit 8, time state 12, bit 12.

To increase testing capability, a high-speed clock is built into the test frame and synchronized by the computer. This clock interrogates the previously computer-controlled registers to generate test programs and patterns. Both the strobes and the current pulses are turned on during the preselected time-state at the given clock rate.

Also, the PMA-8 can easily generate a burst of step or pair repeats during any of the time states. This again is selected using a hardware register that is controlled by the computer and loaded with "ones" and "zeros." If a "one" appears in the register, the time-state generator halts on that time-state and the computer determines the period of time that elapses.

After repeat time has run out in the computer (i.e., the length of time in the time-state generator is stopped), the computer restarts, turns the counter back on, and advances to the next time-state.

The PMA-8 can also vary pulse program length. For example, when doing a read/write, it is only necessary to type a cycle for time state 1 and 2, and not 1 through 12. This is done through a four-bit memory register which predetermines the length of the pulse program. Only selected steps are cycled until the end of program is indicated. The computer then moves on to the next memory address to be tested. Pulse programs of 2 through 12 time-states can be selected.

To optimize the current pulse, the operator types the word CALIBRATE on the teleprinter, he then adjusts his termination networks, provides the proper strobe timing, linearizes the current pulse, and adjusts for coincidence if testing coincident-current memories. Once the operator is satisfied with the adjustments, the PMA-8 is ready to test automatically.

Error Evaluation

During testing, the operator can modify any of the test parameters, request a new test or plot, or even change the parameter limits specified in the "pseudo-instruction" table. For example, an operator may want to change a reference limit to see if the cores that are rejected will meet specifications if the limit is relaxed. The operator can with one command change the reference limit and then with another command restore the original limits. With the PMA-8's six discriminator channels, simple, but extremely accurate, comparisons can be made between a core parameter and a programmed reference level. Error indications can be defined and analyzed whether the parameter value is less than or greater than the present programmed reference levels at the preset strobe time. Using the Teletypewriter, the operator can vary each of the six reference levels to determine the upper and lower limits of core parameters, and automatically obtain quality control data for each memory tested.

Error information from all discriminator channels goes into the computer so that the status of each memory coordinate can be recorded. The computer then evaluates the data, and prints it out on one teleprinter. In this way, a complete permanent record can be made for each memory tested.

Distribution Curve Plotting

This technique is used to calculate the distribution of core outputs in a plane. The PMA-8 scans the plane at a specified reference voltage. If the first strobe sees a "one," a register is incremented. The PMA-8 continues this procedure until it has a complete count of the "ones." The reference voltage is then increased and the PMA-8 counts the "ones" at the new setting. This process is repeated a number of times.

The second count is then subtracted from the first count, the third from the second, etc. The result is a table that shows the difference between each setting. These values are then scaled to a point at which the largest value can be plotted horizontally on the teletypewriter.

When the operator wants a print-out of the distribution curve, he types CURVE on the Teletypewriter. The data is automatically printed out. The curve indicates the relative number of "ones" at each reference. The PMA-8 then repeats the process to obtain information for the remaining strobes.

The following example shows how much of a variance is involved in the distribution of parameters in the mat.

P=7 ST=3

```

028      *
029      *
030      *
031      *
032      *
033      *
034      *
035      *

```

Switching Current Measurements.

A great number of hysteresis loops are possible in any memory core. To plot the effect of variations in these loops, the operator uses the PMA-8 to measure switching currents. Plotting the current measurements for several strobe reference combinations permits the operator to determine the knee currents in the memory.

The PMA-8 plots several strobes for "zeros" and "ones," using either read drivers or write drivers. The plot describes drive current as a function of the number of "ones" detected on a given strobe. The plot shown below indicates the relative number of "ones" at each setting of the write current. The header represents the plane, strobe number, and number of times the data has been scaled.

P000 4003

```

290      *
286      *
282      *
278      *
274      *
270      *
266      *
262      *

```

(continued on reverse)

Core Peaking and Difference Analysis

This technique is used to statistically determine the core peaking time. The PMA-8 statistically analyzes the voltage difference between a pair of strobes, and it also provides error locations if a voltage difference is exceeded.

The PMA-8 calculates the voltage of each specified strobe using a successive approximation technique on a per core basis. The strobe which has the highest voltage recorded is accumulated in a memory register associated with that strobe. At the completion of each plane test, the computer will print out the strobe count. If the strobes are spaced in time about the theoretical core peak, the strobe distribution will provide the actual peak time distribution. If two strobes record the same voltage, the second numerical strobe is counted.

A distribution of voltage difference may also be obtained

by selecting a pair of strobes using the same test parameter. The voltage difference between the strobes is calculated by the computer and the appropriate counter is then incremented. When the plane test is completed, the PMA-8 prints out the counter values. If no strobe was specified for a particular counter its value is not printed out. If more than one pair of strobes were called for, the higher numbered strobe pair will be used for the distribution. If the difference between any pair of strobes exceeds the value defined, the core location and voltages involved will be printed out also.

This technique could also be used to measure the squareness of a hysteresis loop. A core with poor delta noise characteristics can be detected with the PMA-8 independent of all other cores in the plane. The strobes set before and after the peak output detect early and late peaking cores.

Memory Test Analysis Continued

Shmoo Plotting

Shmoo plots are primarily used for laboratory or engineer-evaluations. The PMA-8 plots the characteristic shmoo curve of a memory plane, using a programmed current driver. Curves can be plotted for a single core, section, or all cores of a plane or stack.

The PMA-8 can vary any drive current and plot its effect upon any variation in any other drive currents. The PMA-8 takes the correct number of points until a well-defined shmoo contour is obtained. With the PMA-8's six current drivers, six strobes, and six reference levels, the number of combinations is considerable.

The teleprinter is normally used to plot Error/No Error data on a matrix basis. However, the data can also be recorded on an X-Y plotter. For faster production testing, a contour-following shmoo program will be available at a future date.

```
730 *****
725 *****
720 *****
715 *****
710 *****
705 *****
700 *****
695 *****
690 *****
685 *****
680 *****
675 *****
670 *****
665 *****
660 *****
655 *****
650 *****
645 *****
640 *****
635 *****
630 *****
625 *****
620 *****
615 *****
610 *****
605 *****
600 *****
595 *****
590 *****
585 *****
580 *****
```

(An example of Shmoo Plotting)

Maximum/Minimum Parameter Searches

In this test, the operator uses the PMA-8 to indicate and print out the address and magnitude of the highest and lowest parameters under search — high/low ones/zeros. This can be done at any preselected strobe. The strobes, as well as the time states, are dual functions; i.e., a single strobe may be looking at ones or zeros at any time. As soon as the operator decides which parameters he wants the PMA-8 to plot, the computer sets the correct reference voltage. The planes are then scanned, and the address of any “one,” for example, on each strobe is saved while looking for “zeros”. If any “ones” are present, one half of the original voltage is added to the reference voltage. If no “ones” are present, one half of the original voltage is subtracted from the reference voltage. The process is continued using the values 1/4, 1/8, 1/16, etc., until the fraction equals zero. At this point the PMA-8 prints out all of the data collected and instructs the strobe to look for all “ones,” saving any “zeros” which occur. The operator then gets a print-out of all of the necessary address and magnitude information as a permanent record for the stack under test.

MEMORY TEST ANALYSES

5SDATA.

```
P000 X000 Y000 .B.....
P000 X003 Y000 .B.....
P000 X000 Y001 .B.....
P000 X003 Y001 .B.....
P000 X001 Y002 A.....
P000 X004 Y002 A.....
P000 X006 Y002 A.....
P000 X009 Y002 A.....
P000 X011 Y002 A.....
P000 X012 Y002 A.....
P000 X013 Y002 A.....
P000 X014 Y002 A.....
P000 X015 Y002 A.....
P000 X017 Y002 A.....
P000 X018 Y002
40SV1.
```

```
P000 X000 Y000 .B.....
P000 X003 Y000 .B.....
P000 X000 Y001 .B.....
P000 X000 Y004 .B.....
P000 X003 Y004 .B.....
P000 X000 Y005 .B.....
P000 X001
4SDATA.
```

```
000 * *
001 * *
002
003
004 * *
005 *****
006
007
008 * *
009 * *
010
011
012 * *
013 * *
014
015
016 * *
017 * *
018
019
020 * *
021
022
023 *****
024 * *
025 * *
026
027
028 * *
029
030
```

(An example of GO/NO GO)

There are many types of memory test analyses. Typical examples include GO/NO GO production testing, maximum-minimum parameter searches, several varieties of automatic distribution plot analyses, switching current measurements, core peaking and difference testing, and SHMOO plotting. The PMA-8 can do all of these things well, and when you want them done.

GO/NO-GO Production Testing

GO/NO GO production testing is a fast and accurate method of locating defective cores within each test memory. The operator can immediately determine whether he should perform further testing or memory troubleshooting.

This technique has several sub-routines, including "print errors and proceed," "print errors and hold," and "no stop," that allow the operator to obtain a decimal print-out of the address and cause of failure.

In GO/NO GO testing, fixed limits for the core are stored in the computer. The PMA-8 makes a test pass through the memory and decides if, as in any standard production test, the cores are good or bad.

The PMA-8 then tabulates results in the form of error locations. The address and reason for error are indicated. If during the test, the operator wants to skip certain addresses, he can do so, and no error indication for those addresses will be printed.

SCHMOO

7. SCHMOO FOR IN VS IN FOR UNDISTURBED WAVE
AND UNDISTURBED ZEMOS WITH VARIETIES
FROM 'C' SCHMOO ' AS BELOW
DATED: JAN 25 1967

.0,2.0.SUPAL

185V3

290,130,290,323,0,0,344

.3,340R2

23VERT

55,35,3,-5,5ING

730 *****

725 *****

720 *****

715 *****

710 *****

705 *****

700 *****

695 *****

690 *****

685 *****

680 *****

675 *****

670 *****

665 *****

660 *****

655 *****

650 *****

645 *****

640 *****

635 *****

630 *****

625 *****

620 *****

615 *****

610 *****

605 *****

600 *****

595 *****

590 *****

585 *****

580 *****

575 *****

570 *****

565 *****

560 *****

555 *****

550 *****

545 *****

540 *****

535 *****

530 *****

525 *****

520 *****

515 *****

510 *****

505 *****

500 *****

495 *****

490 *****

485 *****

480 *****

475 *****

470 *****

465 *****

460 *****

455 *****

450 *****

445 *****

440 *****

435 *****

430 *****

425 *****

420 *****

415 *****

410 *****

405 *****

400 *****

395 *****

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230 *****

225 *****

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210 *****

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190 *****

185 *****

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